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(57) Claim

1. A radio activated alarm system comprising a central receiving station having a transceiver and an alarm output means, a plurality of repeater stations spaced from each other and said central receiving station, said repeater stations each having a transceiver and a decoder means, and a plurality of alarm transmitters each having a transmitter and being activatable to transmit a coded alarm signal to an adjacent repeater station wherein said adjacent repeater station receives said coded alarm signal, decodes and verifies said code, and repeatedly ~~re~~transmits an activated alarm transmitter identification signal, according to said coded alarm signal, to said central receiving station to activate said alarm output means and identify said activated alarm transmitter, said adjacent repeater station repeating said transmission until an acknowledgement signal is transmitted by said central receiving station to said adjacent repeater station.

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Complete Specification for the invention entitled:

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RADIO ALARM SYSTEM

The following statement is a full description of this invention, including the best method of performing it known to us
AAC/26P

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ABSTRACT

The present invention discloses a radio activated alarm system formed from a number of alarm transmitters able to be activated by a switch. The switch can be manually operated by a patient or triggered by a burglar or fire alarm. The activated alarm transmitter transmits a short range signal to an adjacent one of a number of repeater stations. The signal is then repeatedly re-transmitted by the repeater station to a central receiving station which raises the alarm and transmits an acknowledgement signal to the repeater station to cancel the repeated re-transmission.

The present invention relates to alarm systems and, in particular, to alarm systems such as are required in community centres where aged and or infirm persons live in independent units. However, the alarm system is not restricted to such use as will be made clear hereafter.

Community centre retirement housing is particularly popular amongst elderly persons since they are afforded a measure of privacy and independence not attainable in dormitory or ward style accommodation. However, coupled with this advantage is the disadvantage that the general well being of such elderly persons must be kept under surveillance in order that prompt medical attention be available in the event of, for example, a fall.

Initially such regular surveillance was carried out manually by the staff of the community centre, however, this proved to be too expensive, particularly out of normal working hours.

It has previously been known to overcome this problem by the provision of a hard-wired alarm system in which one or more alarm switches in each unit are directly connected to a central point such as a reception desk. In the event of an accident or some other situation arising in which an elderly person requires assistance, in order to summon that assistance it was necessary for the elderly person to manually activate the alarm switch.

This creates particular problems where the emergency is, for example, a broken hip caused by a fall of an elderly person from his or her bed. Under these circumstances the injured person may well not be able to reach the alarm switch, even if located on the skirting board as in some installations. A further disadvantage of such installations is the high capital cost of wiring the community centre. Whilst this cost may well be accommodated in building a new centre, it is a particularly expensive item where existing buildings are to be converted for such accommodation.

It is an object of the present invention to overcome, or ameliorate, the abovementioned disadvantages by the provision of a radio activated alarm system.

According to one aspect of the present invention there

is disclosed a radio activated alarm system comprising a central receiving station having a transceiver and an alarm output means, a plurality of repeater stations spaced from each other and said central receiving station, said repeater stations each having a transceiver and a decoder means, and a plurality of alarm transmitters each having a transmitter and being activatable to transmit a coded alarm signal to an adjacent repeater station wherein said adjacent repeater station receives said coded alarm signal, decodes and verifies said code, and repeatedly retransmits an activated alarm transmitter identification signal according to said coded alarm signal to said central receiving station to activate said alarm output means and identify said activated alarm transmitter, said adjacent repeater station repeating said transmission until an acknowledgement signal is transmitted by said central receiving station to said adjacent repeater station.

Two embodiments of the present invention will now be described with reference to the drawings in which;

Fig. 1 is a schematic illustration of the components of the system,

Fig. 2 is a schematic block diagram of the components of the repeater station of a first embodiment,

Fig. 3 is a schematic block diagram of the components of the central receiving station of a first embodiment,

Fig. 4 is a schematic block diagram of the components of the repeater station of a second embodiment,

Fig. 5 is a schematic block diagram of the components of a repeater station of a second embodiment, and

Fig. 6 illustrates the code format used in the second embodiment.

As seen in Fig. 1 the system is made up from a central receiving station 1, a relatively small number of repeater stations 2 each located at a spaced interval from each other and the central receiving station 1, and a relatively large number of alarm transmitters 3.

In the main, the alarm transmitters 3 are personal alarm transmitters carried by individual residents of the community housing system. Such alarm transmitters are of a small size and light weight, are powered by a small battery and are

activated by a switch.

However, the alarm transmitters can also include stationary mains powered alarm transmitters intended to indicate the presence of fire or intruders, such transmitters being based upon conventional smoke detectors or burglar activated switches which take the place of the manually operated switch of the portable alarm transmitter.

Thus it will be appreciated that although the preferred embodiment of the present invention will be described with reference to an alarm system for a community retirement centre, the present invention is not restricted to this application or analogous applications such as hostels, hospitals and nursing homes. The invention is also applicable to remote alarm indication for machinery, the protection of paintings and other valuable portable or movable objects such as motor vehicles, the remote indication of open doors, and farm gates, and so on. Thus the application of the invention is dependent upon the function(s) being sensed by the switch in the alarm transmitter(s).

When activated, the alarm transmitter transmits a pulse width modulated coded 12 bit radio signal which is coded so as to indicate the number allocated to the particular transmitter. The pulse width modulation is used to frequency shift key between two predetermined frequencies with the duration at any one frequency being determined by the PWM. The allocated number is determined by programming a set of slide switches (not illustrated). The alarm transmitters each preferably include a timer circuit with a short activation delay which guards against accidental triggering or momentary operation of the switch. After the short delay the timer circuit latches and the alarm transmitter continues to function even if the switch is no longer depressed as would be the case for an unconscious patient. The alarm transmitter can either switch off automatically after a predetermined time or can re-transmit for short periods until a re-set button is pushed. This latter arrangement has the advantage that one of the nursing staff must go to the emergency site to cancel the transmission. Transmitting repeatedly for short periods at a low duty cycle allows a number of alarm transmitters to

activate the receiver within a short period of time without interference to each other.

The transmitter power and antenna are such that the range of the transmission is of the order of one hundred metres and preferably from sixty to two hundred and fifty metres. Within this range is located at least one of the repeater stations 2.

As seen in Fig. 2, each repeater station 2 incorporates a micro processor 4, a receiver 5, a transmitter 6 and an antenna switch 7. In addition, code switches 8 and 9 are provided to enable identification of the system code and the code to indicate the number of the repeater. Finally, a memory store in the form of both a random access memory (RAM) 10 and a read only memory (ROM) are connected to the micro processor 4 via a data bus 12.

As seen in Fig. 3, the central receiving station is to some extent similar to the repeater station 2 but incorporates a 24 hour timer 15 and a display decode circuit 16 which is connected to the data bus 12 and which operates a liquid crystal display 17. Also connected to the data bus 12 is an output data latch 18.

Connected to the micro processor 4 is a memory view switch 19, line isolation circuitry 20 and output relays 21. The line isolation circuitry 20 enables data to be output to a remote display connected via a data line whilst the output relays 21 enable control signals of either a momentary or latched character to be sent to control external devices. Finally, the central receiving station micro processor 4 is connected to a bank of call origin lights 22 which are activated to indicate the nature of the originating transmission.

In operation, one of the alarm transmitters 3 is activated and transmits its coded alarm signal to at least one of the repeater stations 2. A repeater station 2 receiving such a signal verifies the received code is one of its permissible received codes, and thereby transmits a 16 bit signal to the central receiving station 1 which identifies both the nature of the original alarm transmission (whether personal, fire or intruder) and also identifies itself by

means of the further 4 bits added by the repeater to the alarm transmitter signal, thus the extra 4 bits form a code unique to that repeater station 2. The transmission of the repeater station 2 is repeated at predetermined intervals until an acknowledgement signal is received from the central receiving station 1 in which case the transmission is terminated.

Obviously if several repeaters receive the alarm transmission at once and try to re-transmit it simultaneously the result will be mutual interference and there is the possibility of no correct transmission being received.

Each repeater in the system is therefore allocated an individual number set on slide switches. This number is used to set the time delay from when the repeater receives the alarm transmission to when the repeater transmits. In this way each repeater is allocated a transmit time window so even if several repeaters are activated they will not transmit at once.

In addition to this the repeaters will not re-transmit an alarm transmission which any other repeater has recently re-transmitted.

All repeaters will re-transmit a signal transmitted by a repeater coded repeater number zero for use with a digital paging system described later.

Repeaters can be either solar or mains powered and can be used with an antenna mounted onto their case or an antenna mounted remotely.

At the central receiving station 1, the signal from a repeater station 2 is received, decoded and the code verified as being one of a permitted number of codes. After successful verification, the coded data is displayed on the display 17 to indicate the number of the repeater station originating the transmission, thereby effectively raising the alarm. In addition, the nature of the alarm is displayed on the call origin lights 22.

In addition, correct verification of the code activates the transmitter 6 of the central receiving station 1 which then transmits an acknowledgement signal to all the repeater stations 2. The acknowledgement signal is coded to ensure that only the correct repeater station 2 is acknowledged and

thereby deactivated.

Subsequent transmissions from different alarm transmitters are processed in the same way with the exception that the second and third numbers are displayed in the second and third positions of the display 17. Therefore three alarm numbers can be displayed simultaneously so staff can make an immediate judgement which requires most urgent attention.

Further calls are placed into a memory and can be recalled using a memory roll switch.

Each display position has a separate reset switch which cancels the call displayed on that display only. In this way staff can cancel calls individually after the necessary action has been taken without cancelling other calls.

The central receiving station 2 has three alarm states for the entire installation as well as a system fail alarm including failure of power. There is capacity for communicating with in excess of 300 alarm transmitters and individual alarms are registered in the memory store and displayed until reset. In the event that further calls are received before a preceding call has been answered, a call waiting light (not illustrated) is illuminated to indicate to the operator of the central receiving station that a further alarm will be activated in the near future. Following acknowledgement of the preceding alarm the subsequent alarm is then displayed.

At predetermined time intervals, the central receiving station 1 transmits a test signal to each of the repeater stations 2, in turn, to check on their operation. Upon receipt of a test signal, each repeater station 2 checks the validity of the incoming code and compares it with its own memory. The repeater station 2 recognises the incoming code as a test code and retransmits the test signal back to the central receiving station 1 with additional coded information to notify the central receiving station 1 of the correct operation of the repeater station 2. Failure of the central receiving station 1 to receive a correctly retransmitted test signal from any one of the repeater stations 2 will activate an alarm and display the number of the faulty repeater station 2 at the central receiving station 1.

One disadvantage of the system as described is that the on duty staff must go to the central receiver to identify an emergency call. This can be time wasting in a situation where time taken to render assistance is critical.

To overcome this disadvantage the alarm system can include a digital paging system.

The digital pager is essentially a miniature central receiver with a single digital display, battery power and an internal loop receiving antenna. The pager is designed to be worn or carried by the user and when activated emits a beeping noise to alert the user. The number of the activated alarm transmitter is displayed and further calls are placed in a memory. Three push buttons are provided for alarm stop, memory roll, and reset. The calls can only be reset by pushing the reset and alarm stop buttons simultaneously to guard against accidental cancellation.

As the loop antenna in the pager is quite inefficient the pager receiver is not capable of receiving the transmissions from the alarm transmitters over a useful distance. To overcome this the central receiver and system of repeaters are used to re-transmit the alarm transmission.

When the central receiver has identified and displayed an alarm transmission it re-transmits the 12 bit code plus 4 bits in the same way as a repeater re-transmits the alarm transmission. The central receiver is numbered as repeater zero and as previously discussed all repeaters in the system re-transmit this transmission at their transmit time window.

The signal is re-transmitted throughout the system no matter how large the complex, to the pager receiver.

In addition, the central receiver is also preferably provided with a serial port interface for connection to a printer to log the time, date, and alarm transmitter number, or connection to a computer system.

When connected to a computer system the central receiver can initiate the fetching of a patient's stored file to display relevant information such as medication, family contacts, machinery information, etc.

The central receiver is capable of testing each repeater in the network to ensure its correct operation. This is

carried out by the central unit sending a transmission to each repeater in the system and expecting a reply. If the repeater is unable to reply within the time span alloted the central equipment will adopt an alarm state and notify which repeater unit has failed the test procedure.

This failure is also capable of testing each sensor in a security application to ensure that all sensors are active and in working condition.

Sensors are capable of transmitting a signal to signify a low battery state is present as well as a tamper alarm to prevent unauthorised removal of the sensor from the system.

The system can also be used in other applications whereby a transceiver is fitted to various pieces of equipment such as containers in a freight yard, or railway carriages to enable them to be located.

This is carried out by the central receiver sending out a signal to a particular transceiver to gain a reply. The transceiver, if it is within range will then respond with a correct transmission to establish its presence in the yard or area.

A further application enables the location of the transmitter or transceiver to be determined by the setting up of a grid of repeaters to establish the location of the transmitter. This is carried out by accurately determining the time taken for the transmission to reach two or more repeater units. The timing for this is carried out by each repeater incorporating a timing circuit to enable it to keep precise time with the other repeaters in the system as well as the master control unit. This is carried out by the master unit sending a timing pulse to each repeater unit at predetermined intervals whereupon they reset an extremely accurate internal clock. The time taken for a transmission to travel from the transmitter to the repeater unit can then be accurately measured and the location of the source of the transmission to travel from the transmitter to the repeater unit can then be accurately measured and the location of the source of the transmission can be determined by the central receiving station.

With this arrangement it is possible to not only

determine the presence of a transmission and the identity of the transmitter it is also possible to accurately locate the source. Thus it is possible to locate a transmission from either a personal transmitter or a piece of equipment anywhere within the boundary of the system. The system can cover the whole of a city and size of Sydney and not only identify that a particular person with an alarm transmitter is in need of help but also that the person concerned is in a particular street some miles away from home.

The system can be expanded to cover very large areas. It has found use in whole towns or communities with the central receiver located in a community centre or hospital.

The second embodiment described above and illustrated in Figs. 4 to 6 basically comprises a single chip microcomputer such as MOTOROLA MC146805 or another member of that family with the above described functions being embodied within the chip.

The foregoing describes only some embodiments of the present invention and modifications, obvious to those skilled in the art, can be made thereto without departing from the scope of the present invention. For example, the liquid crystal display 17 could be replaced with rows of indicator lamps or lights.

The claims defining the invention are as follows:

1. A radio activated alarm system comprising a central receiving station having a transceiver and an alarm output means, a plurality of repeater stations spaced from each other and said central receiving station, said repeater stations each having a transceiver and a decoder means, and a plurality of alarm transmitters each having a transmitter and being activatable to transmit a coded alarm signal to an adjacent repeater station wherein said adjacent repeater station receives said coded alarm signal, decodes and verifies said code, and repeatedly ~~re~~transmits an activated alarm transmitter identification signal, according to said coded alarm signal, to said central receiving station to activate said alarm output means and identify said activated alarm transmitter, said adjacent repeater station repeating said transmission until an acknowledgement signal is transmitted by said central receiving station to said adjacent repeater station.

2. A system as claimed in claim 1 wherein said alarm transmitters are portable and the range of said transmitted coded alarm system includes at least one of said repeater stations.

3. A system as claimed in claim 1 wherein said alarm transmitter is activated by a stationary switch the operation of which is indicative of the alarm function to be sensed.

4. A system as claimed in any one of the preceding claims wherein each of said alarm transmitters when activated ~~repeated~~ repeatedly re-transmits said coded alarm signal until re-set.

5. A system as claimed in any one of the preceding claims wherein each of said repeater stations includes a delay means to delay said re-transmission by a predetermined time, each of said repeater stations having a unique predetermined time to prevent simultaneous receipt of a plurality of said re-transmissions by said central receiving station.

6. A system as claimed in any one of the preceding claims wherein said central receiving station at predetermined time intervals transmits a coded test signal to said repeater stations, each of said repeater stations checking said coded test signal with a stored code and, in the event of identity, transmitting an acknowledgement signal to said central

receiving station.

7. A system as claimed in claim 6 wherein said central receiving station transmits, in turn, a coded text signal corresponding to the stored code of each of said repeaters.

8. A system as claimed in any one of the preceding claims wherein said central receiving station is adapted to sequentially receive a plurality of said ~~re~~ repeater station transmissions each from a different one of said repeater stations and identify the corresponding different activated alarm transmitters.

9. A radio activated alarm system substantially as described with reference to the drawings.

DATED this NINTEENTH day of OCTOBER 1984
VITAL COMMUNICATIONS PTY. LTD.

Patent Attorneys for the Applicant
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AAC/18o

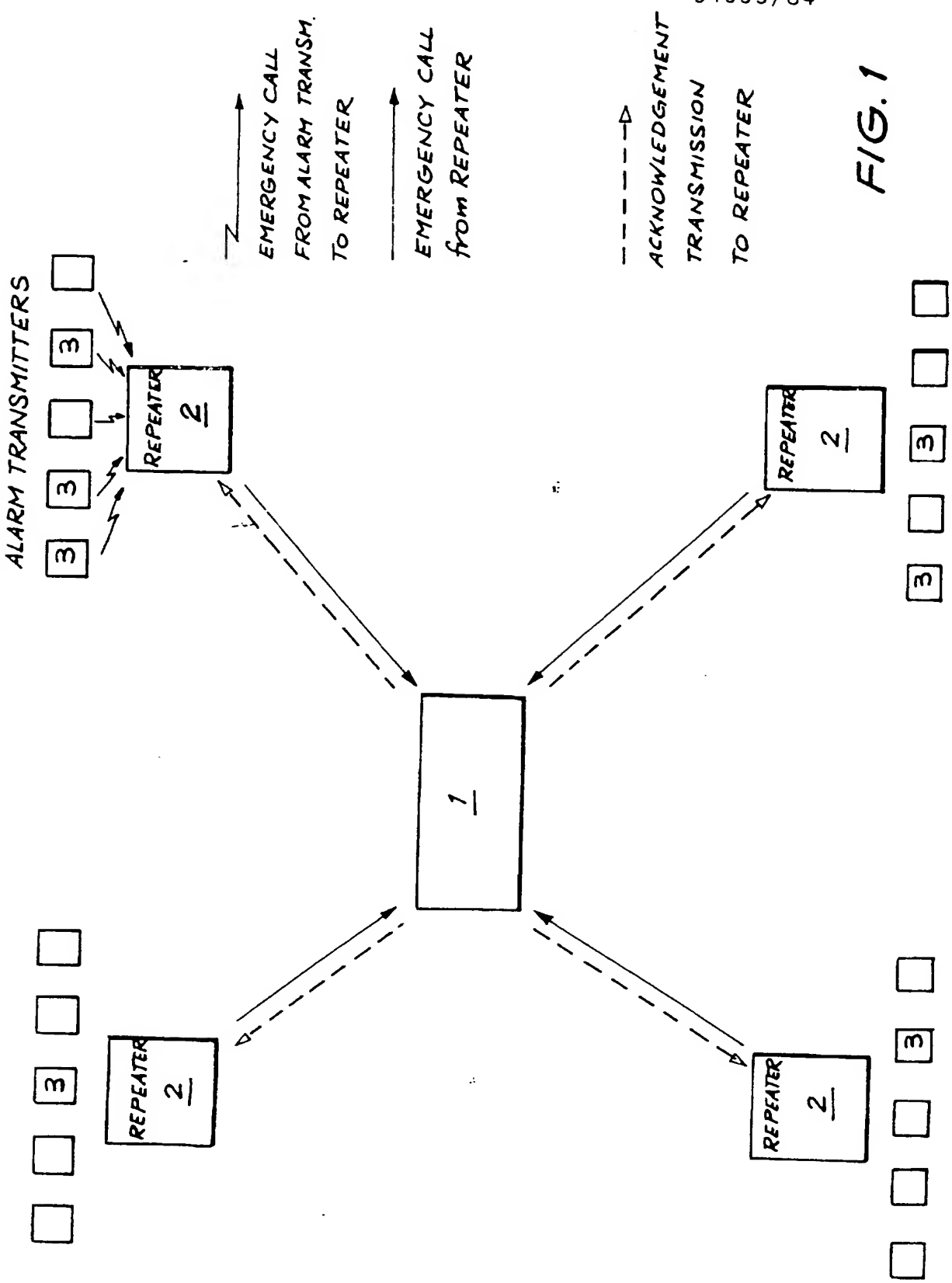


FIG. 1

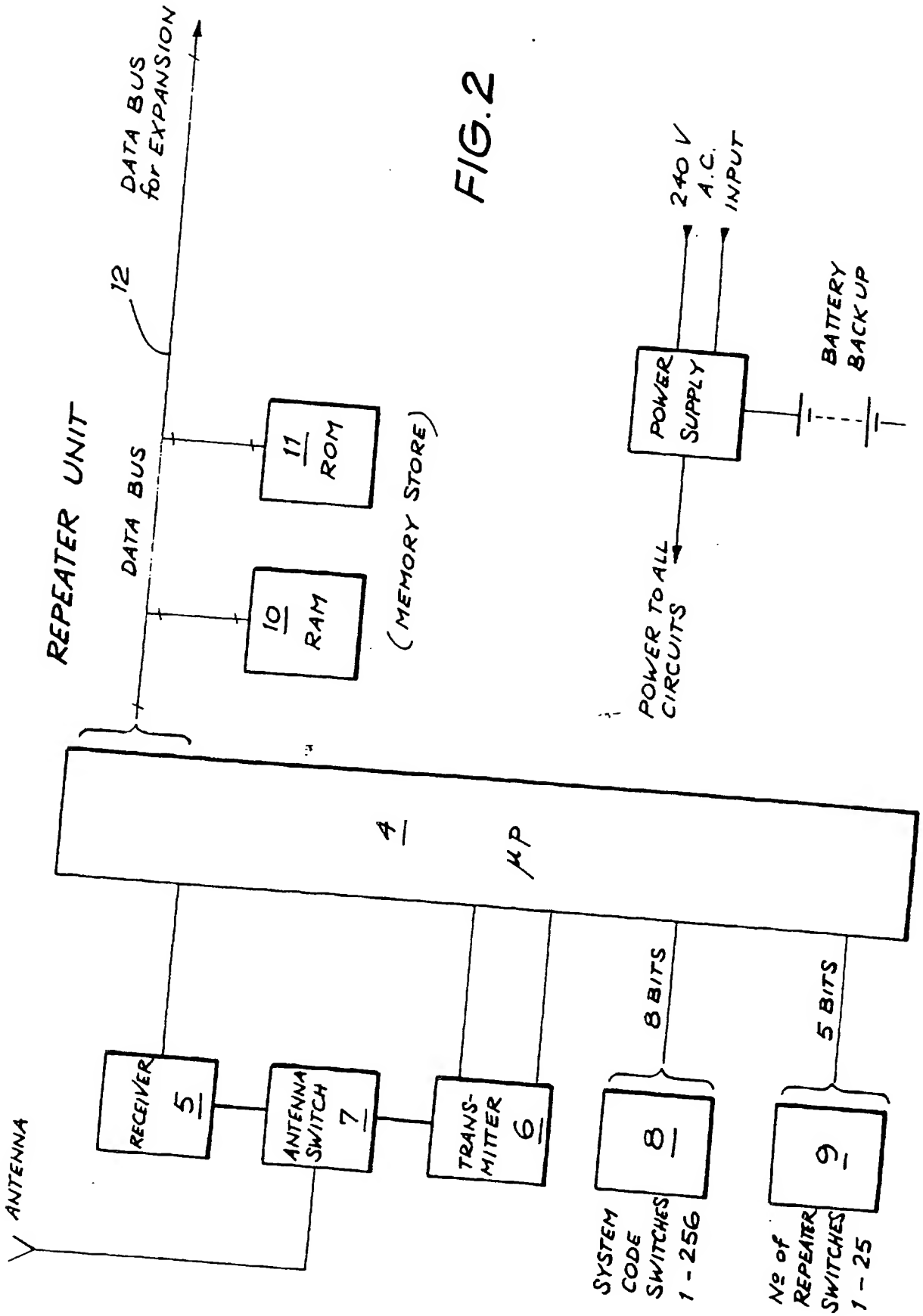


FIG.2

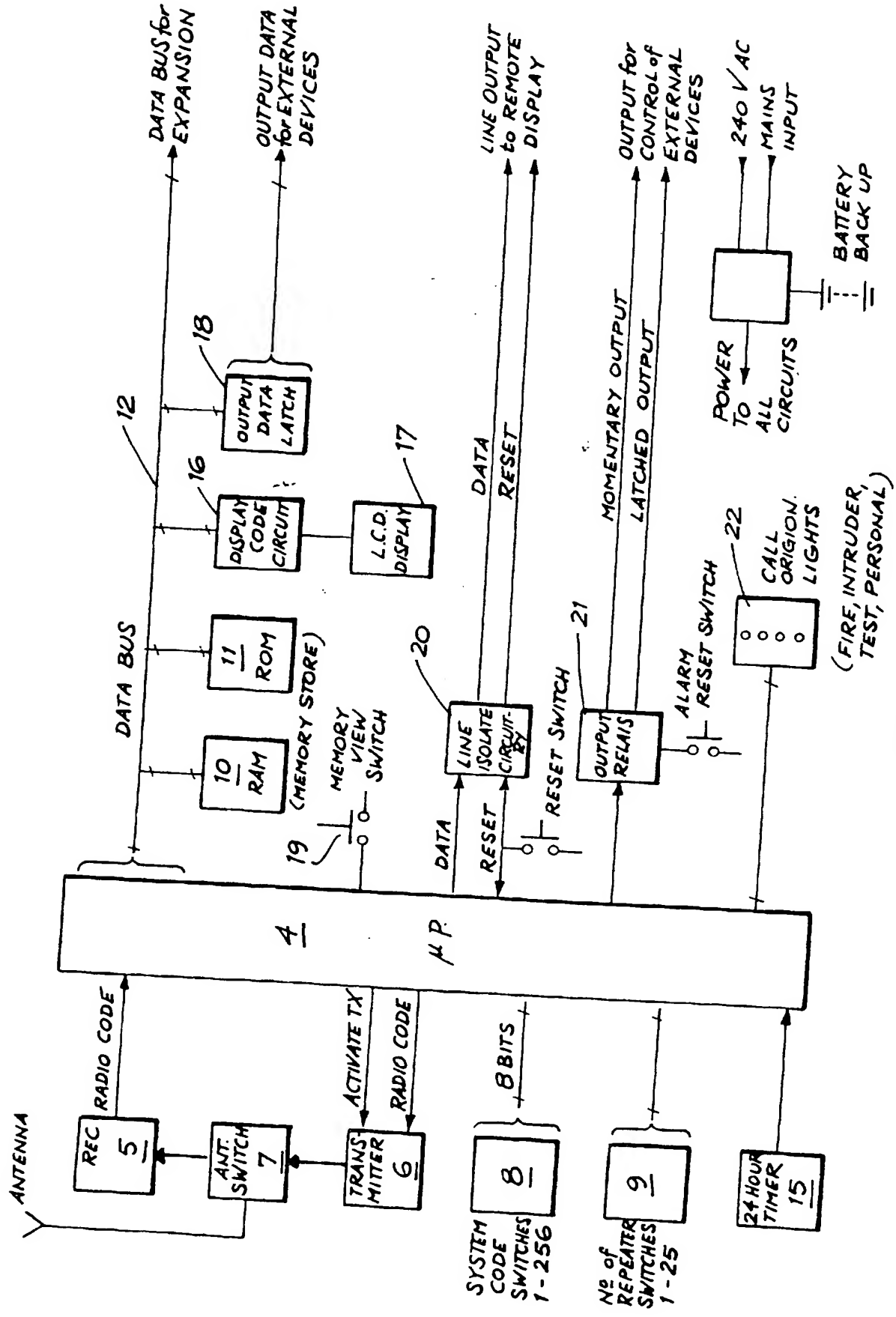


FIG. 3

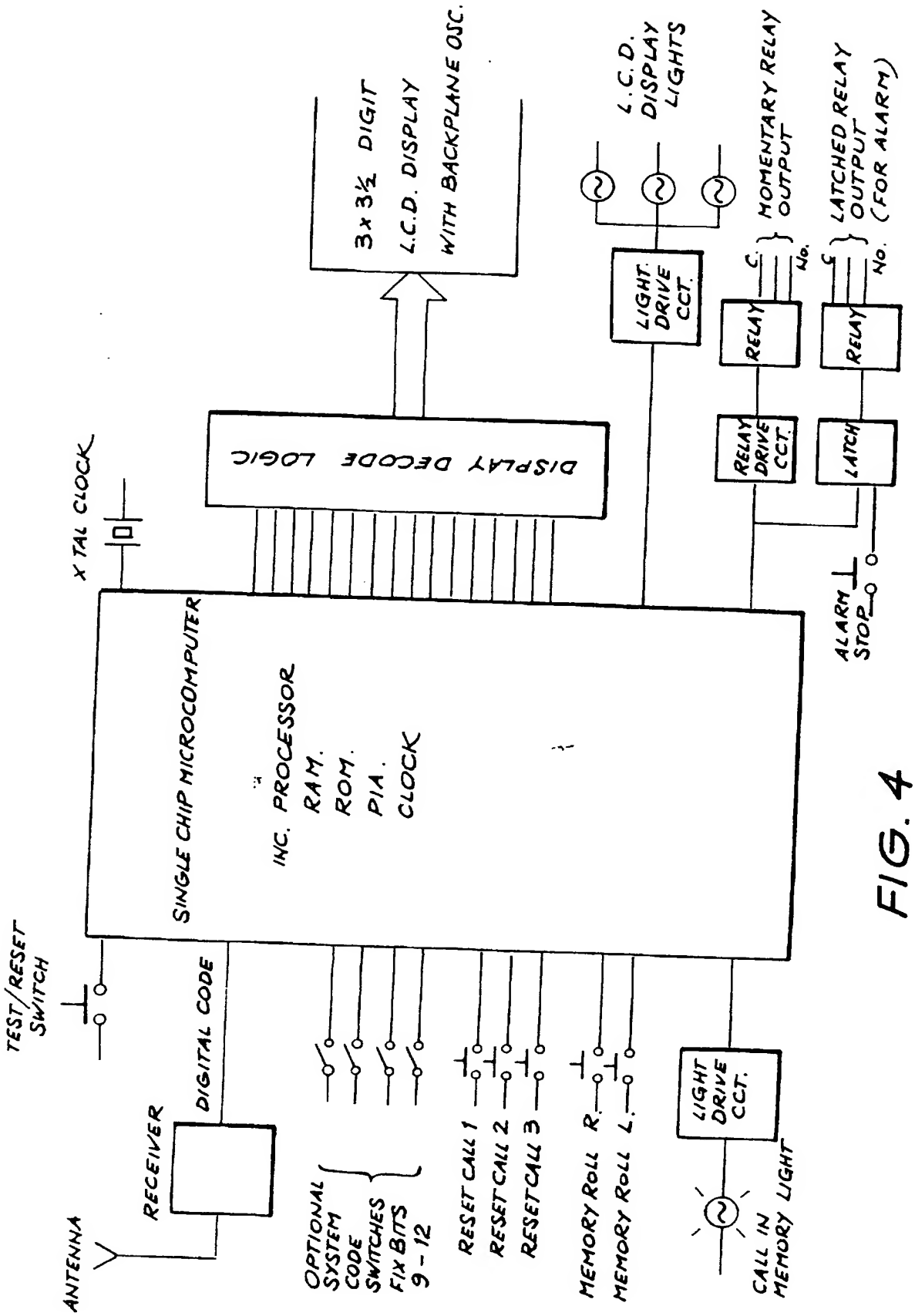


FIG. 4

CODE FORMAT

PORTABLE TRANSMITTER

1	2	3	4	5	6	7	8	9	10	11	12

REPEATER

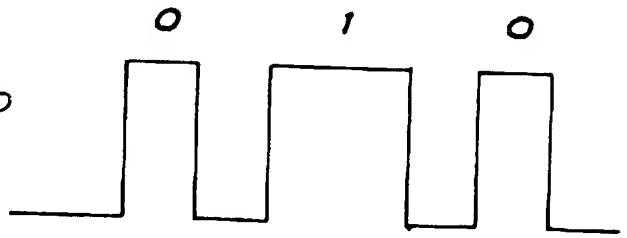
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

12 BIT CODE TRANSMITTED BY PORTABLE ALARM TRANSMITTER Nº 1 – 4096

ADDITIONAL 4 BITS IDENTIFYING REPEATER Nº 1-16

FIG. 6

PULSE WIDTH MODULATED CODE WAVEFORM



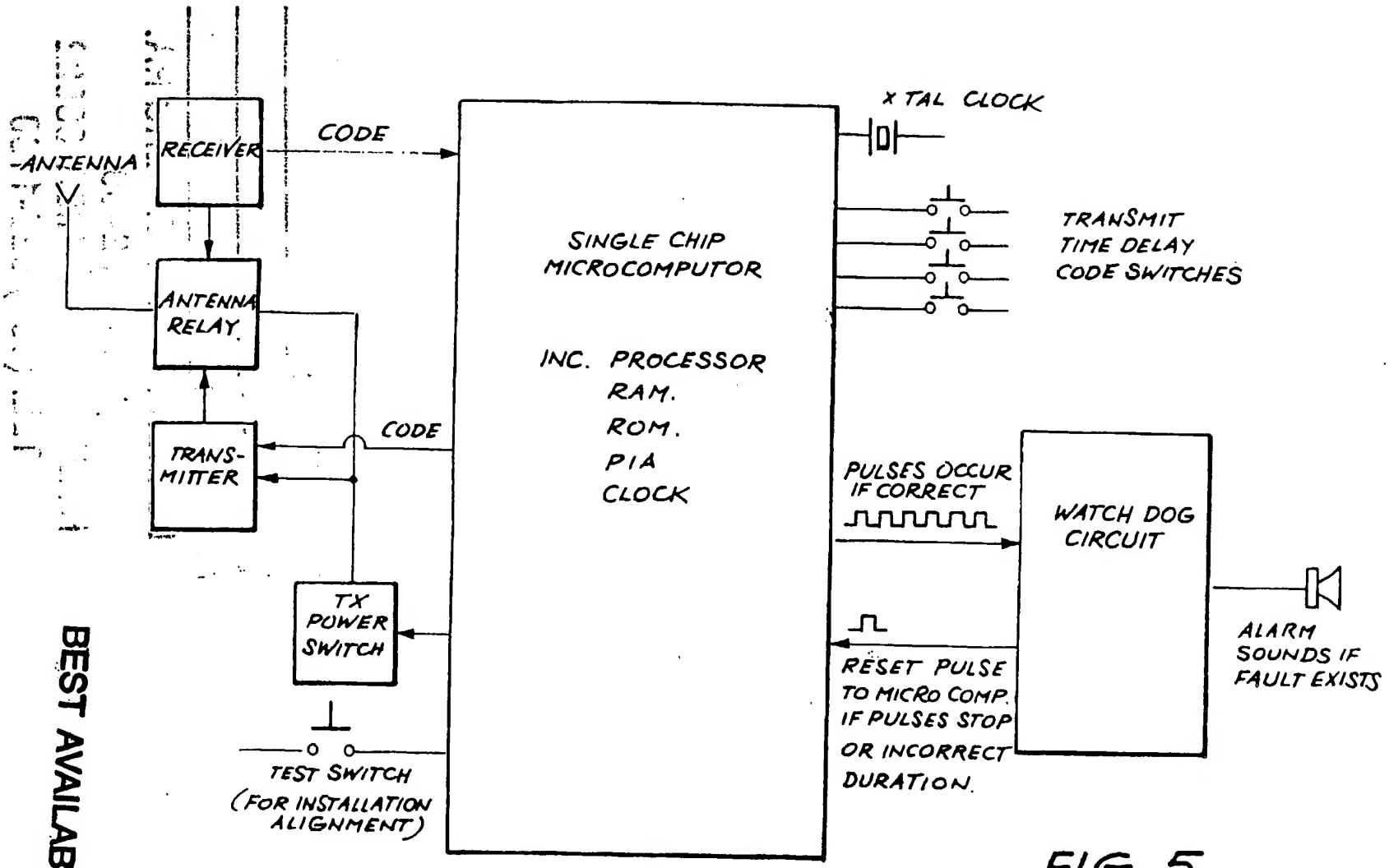


FIG. 5

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